



# HIRS Daily OLR Climate Data Record Development and Evaluation

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# Overview

- **New 1°x1° Daily OLR CDR (v01r02 beta3c) 1979-2012:**
  - **HIRS** onboard NOAA and ESA operational polar-orbiting satellites
  - **Imagers** onboard multi-national geostationary satellites
- **Revised OLR regression models** – improve retrieval consistency; greatly reduced inter-satellite calibration errors; increased OLR time series stability
- **LEO/GEO Blending** - Imager OLR is normalized to HIRS OLR in a *grid-by-grid 7-day boxcar*
- **Significant improvements** - Spurious trend in global mean OLR previously shown in current HIRS Monthly OLR CDR was removed.

# **OLR Estimation Method**

# Multi-spectral HIRS OLR Algorithm

$$OLR = a_0(\theta) + \sum_i a_i(\theta) \cdot N_i(\theta)$$

*Old:*

*HIRS-2:*

*Channels: 3, 7, 10, 12*

*HIRS-2I/3/4:*

*Channels: 3, 10, 11, 12*

$a_i$ =regression coefficients  
Ellingson et al. (1989)

*New:*

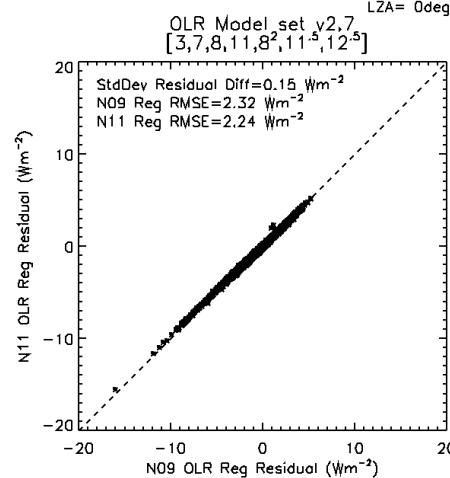
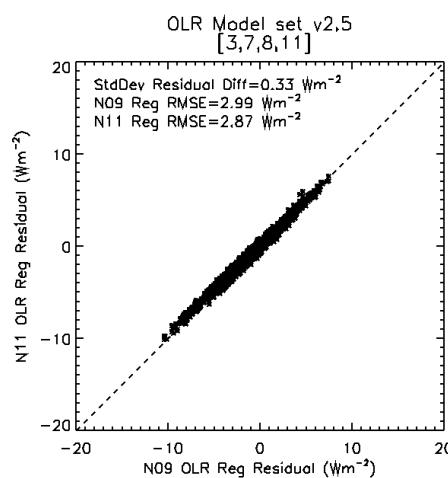
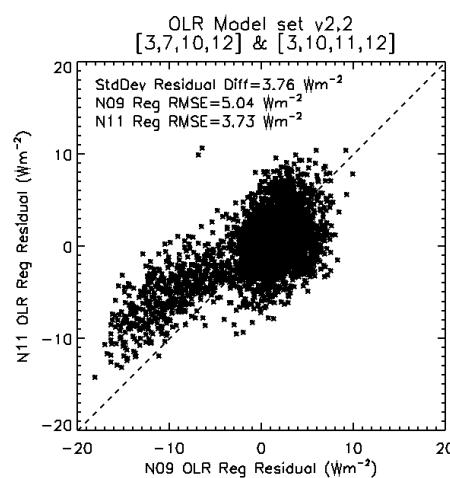
*HIRS-2/2I/3/4:*

*Predictors: 3, 7, 8, 11, 8^2, 11^{0.5}, 12^{0.5}*

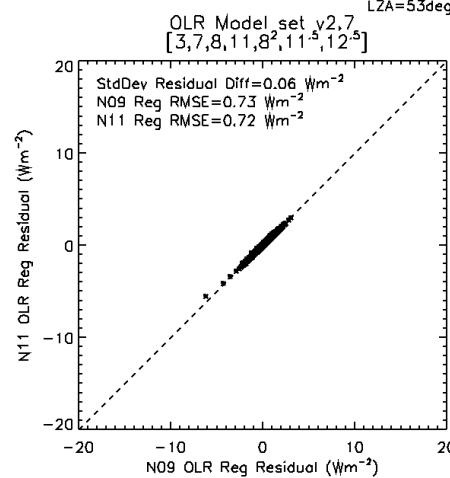
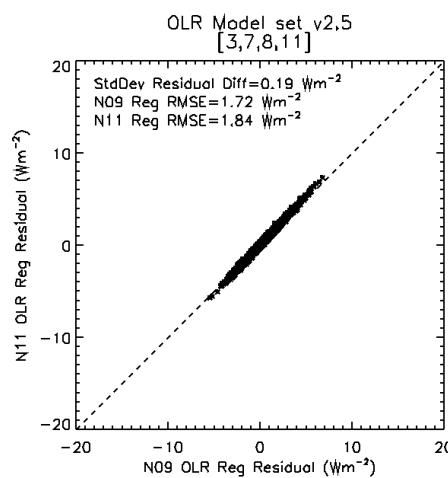
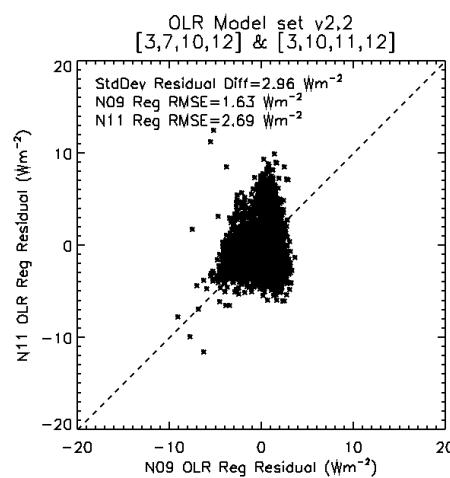
# Improvement in OLR Models

## Consistency in Residual Behavior

**NOAA-11 vs. NOAA-09**



**LZA=0°**



**LZA=53°**

**Old**

**New**

# Imager OLR Algorithm

$$OLR = \sigma T_f^4$$

$$T_f^4 = (a_0 + a_1 T_{win}) \cdot T_{win} + (b_0 + b_1 T_{wv}) \cdot T_{wv}$$

$a_i, b_i$ =regression coefficients

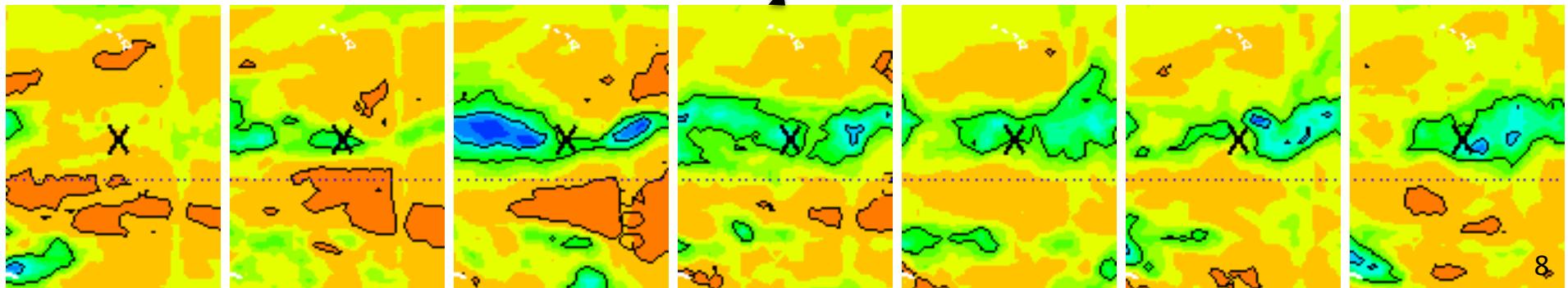
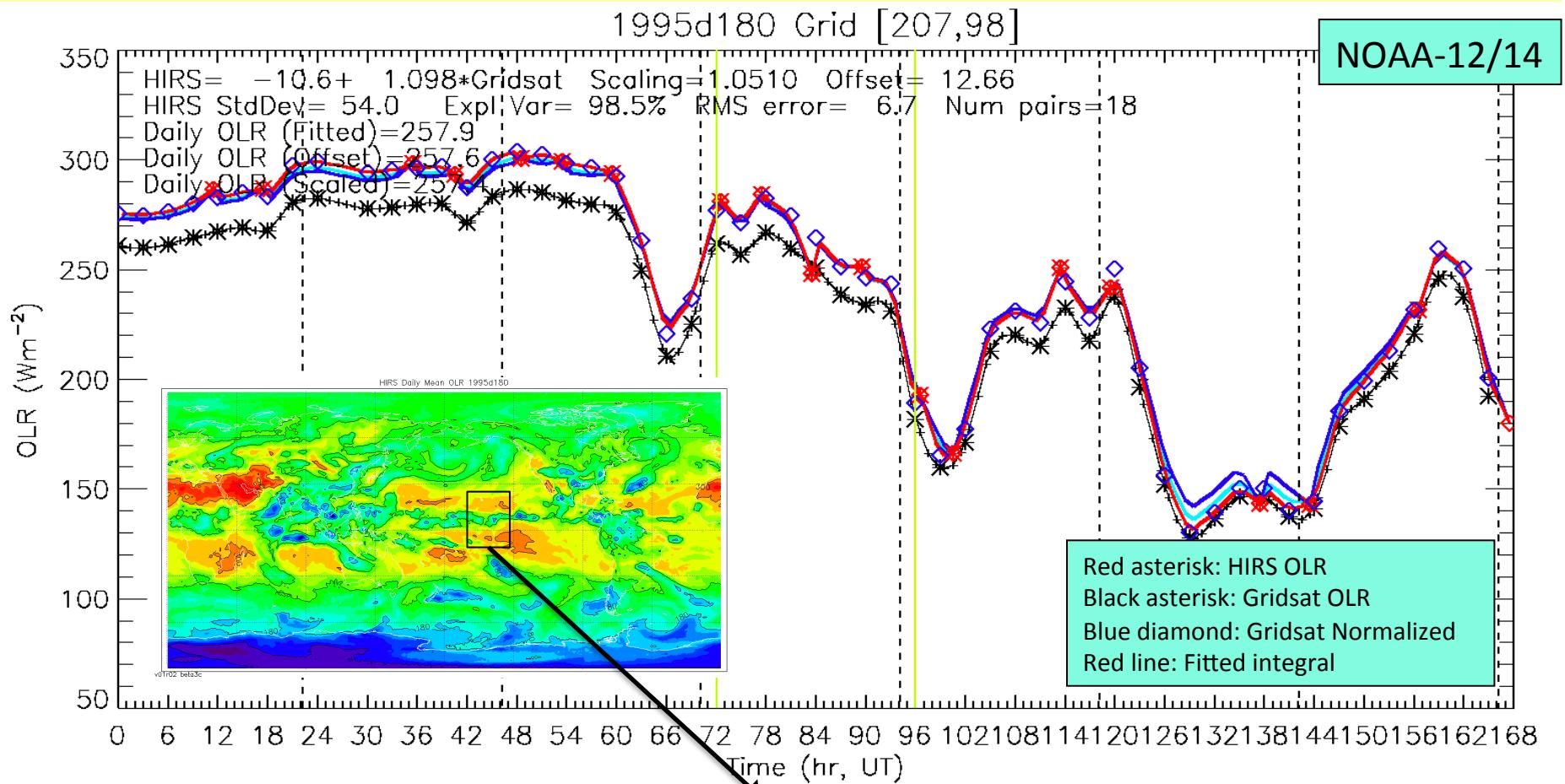
Adapted from Wark et al (1962)

**Gridsat CDR Product (v2.2)** (Knapp et al, 2011) provides cross-calibrated brightness temperatures for the atmospheric window and  $\sim 6.7 \mu\text{m}$  water vapor channels, with limb correction applied, for 1980-2012. (Calibration reference is NOAA-14 HIRS channels 8 and 12).

# Radiometric Normalization and Temporal Integration Schemes

*“Grid-based 7-day Boxcar”*

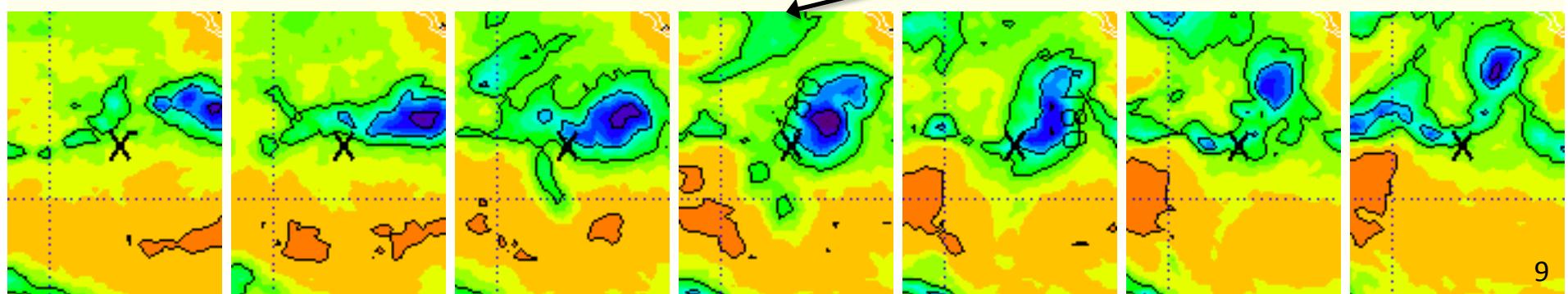
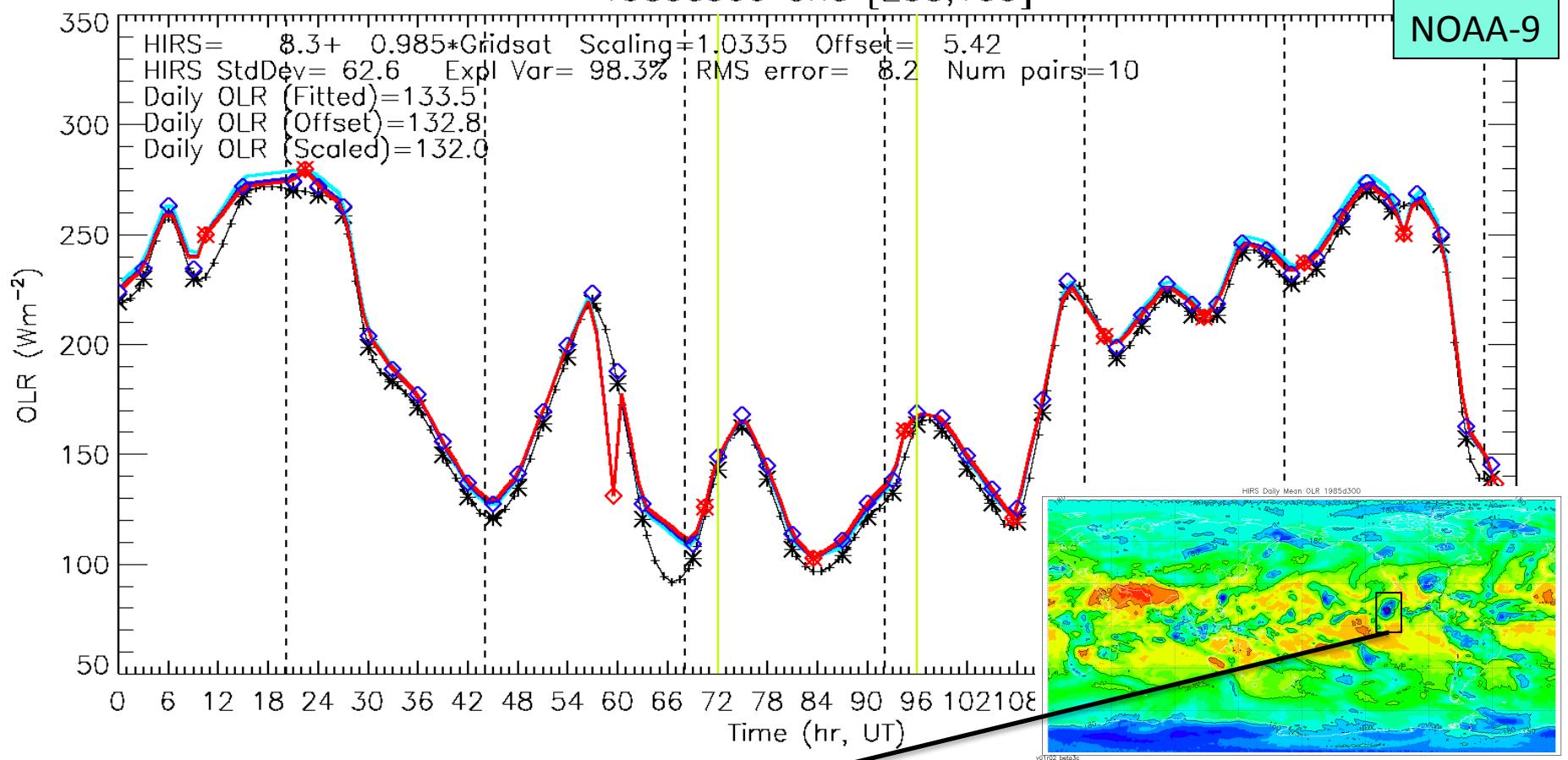
# 7-day Boxcar for 1995day180



# 7-day Boxcar for 1985day300

1985d300 Grid [238,100]

NOAA-9



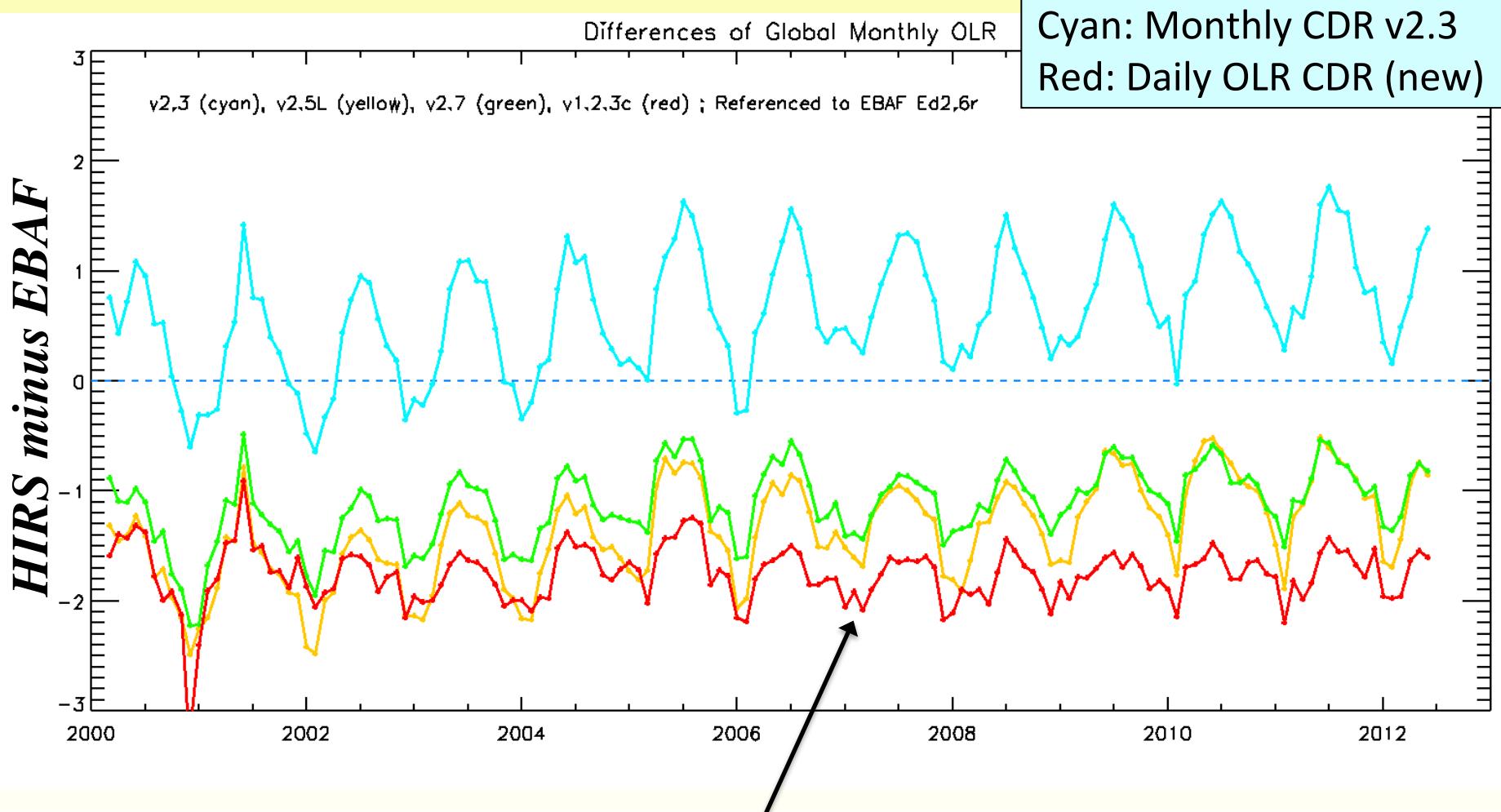
# **Inter-comparison**

**HIRS Daily OLR CDR**

**vs.**

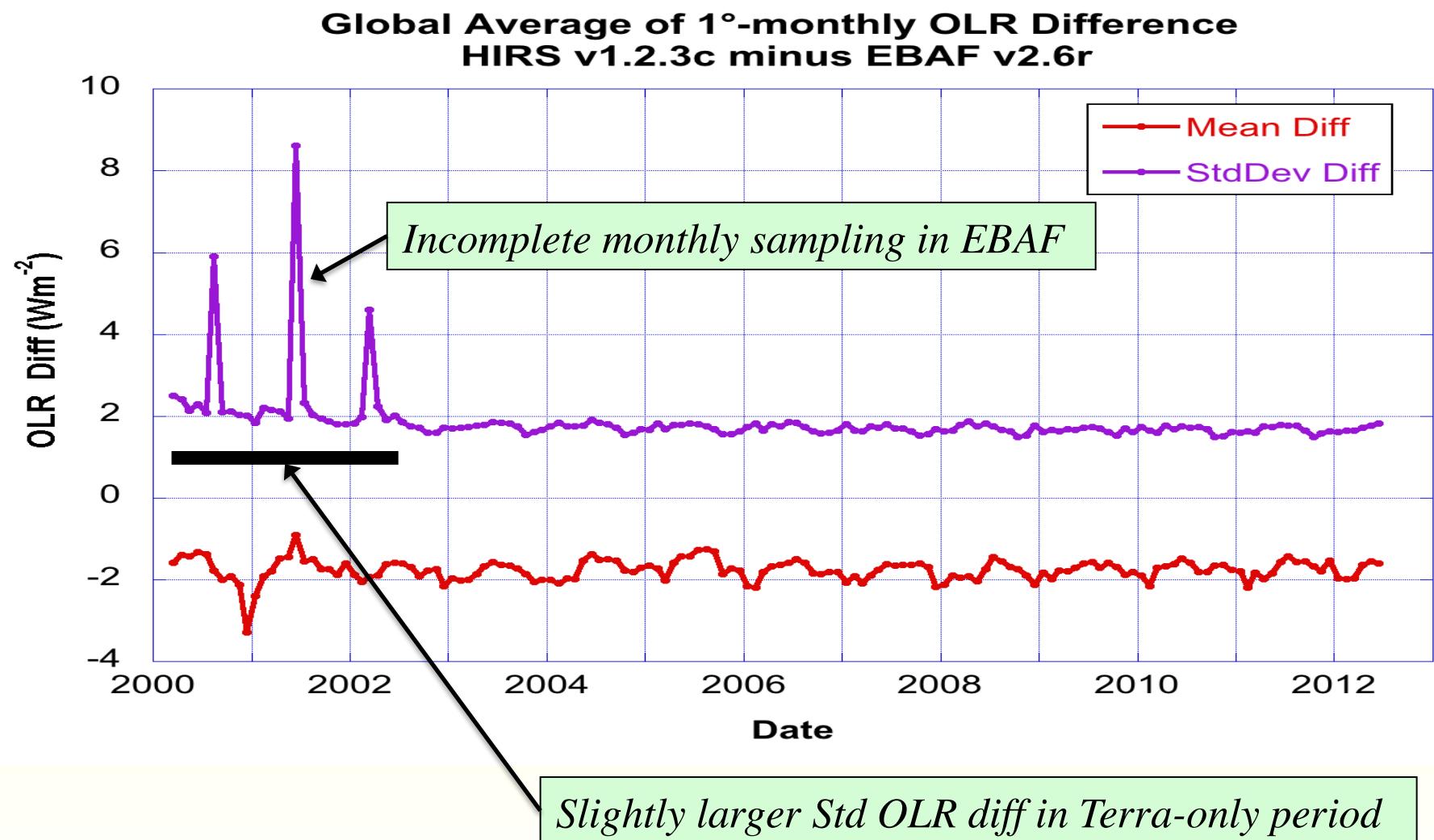
**EBAF Ed2.6r  
(in monthly means)**

# Global Monthly OLR Differences 2000-2012

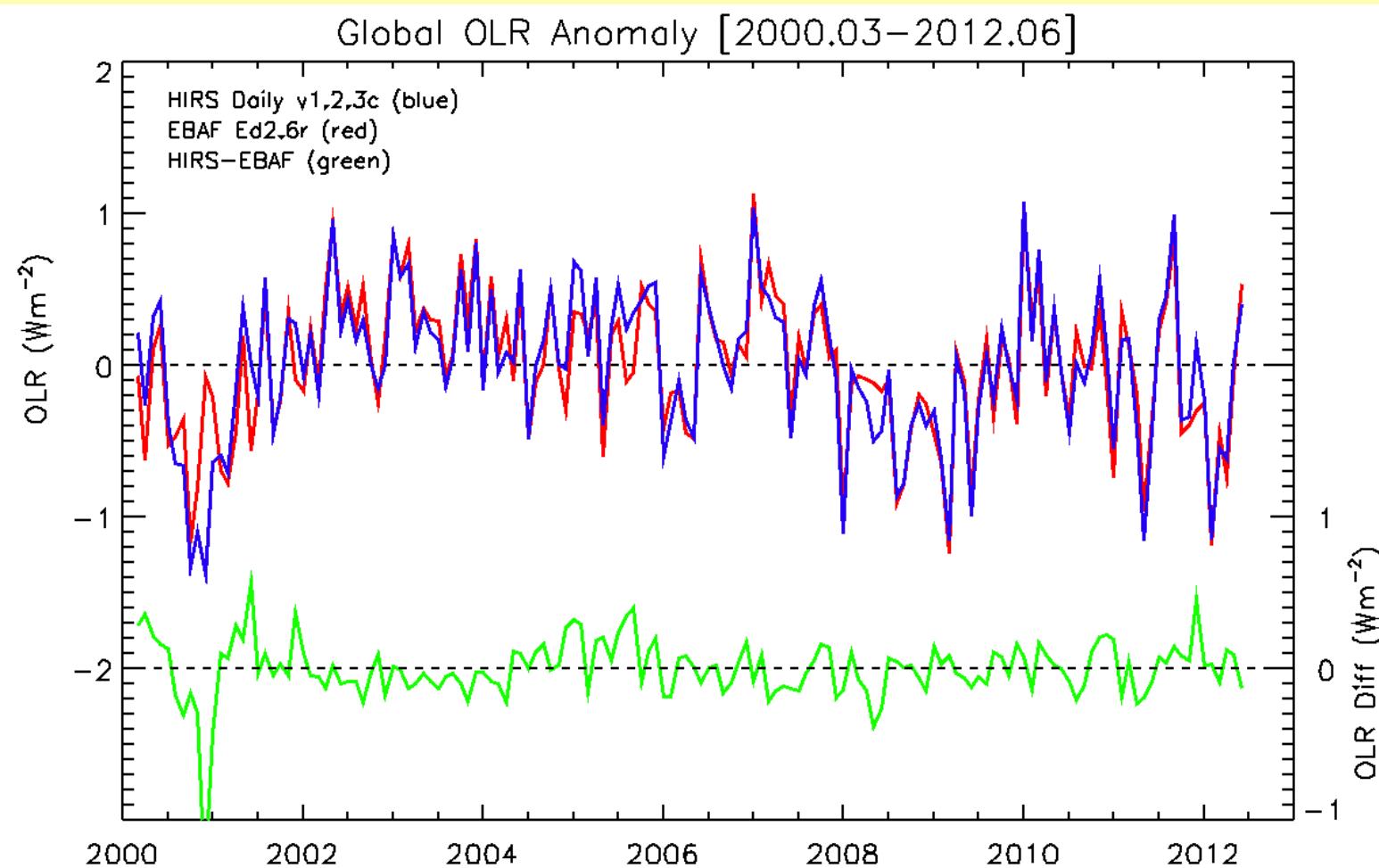


*Much improved agreement in annual cycle between HIRS and EBAF*

# HIRS-EBAF Global Monthly OLR Differences 2000-2012

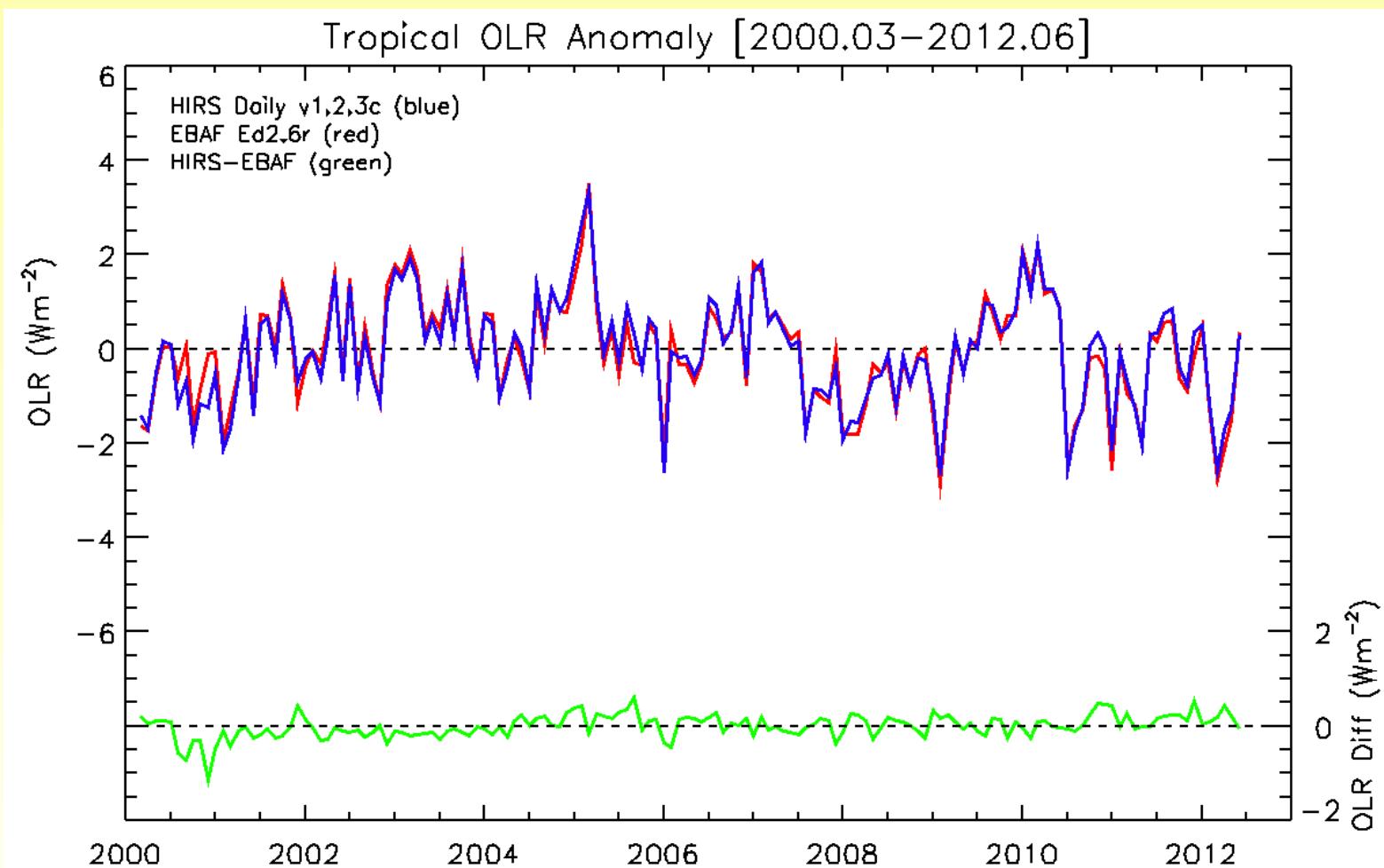


# Global OLR Anomalies (2000-2012)



*Slope of OLR anomalies diff =  $0.03 \pm 0.09 \text{ Wm}^{-2}/\text{decade}$  with 2-sigma*

# Tropical OLR Anomalies (2000-2012)



*Slope of OLR anomalies diff =  $0.28 \pm 0.10 \text{ Wm}^{-2}/\text{decade}$  with 2-sigma*

# **Inter-comparison**

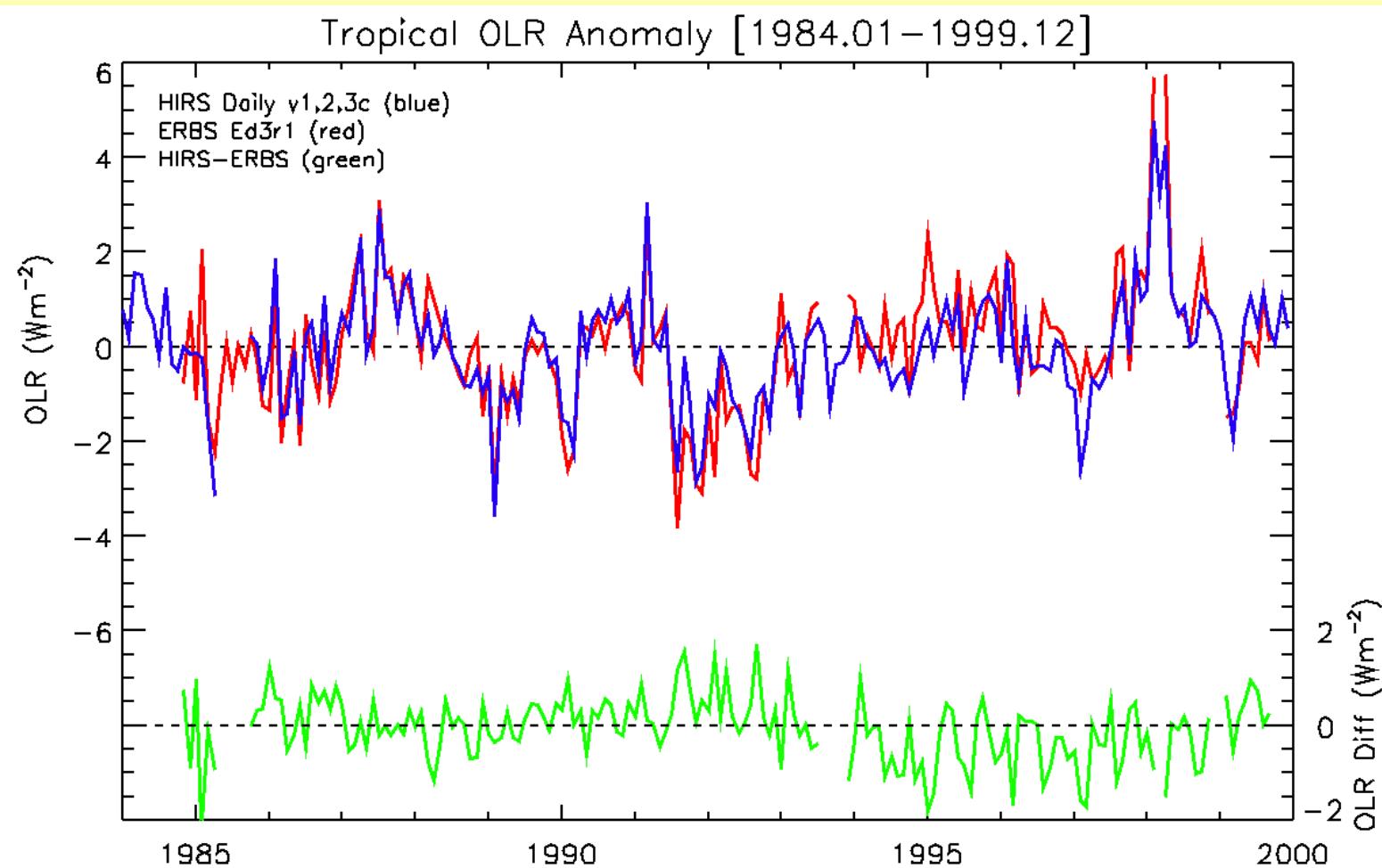
**HIRS Daily OLR CDR**

**vs.**

**ERBS Ed3\_rev1**

**(in monthly means)**

# Tropical OLR Anomalies (1985-1999)



*Slope of OLR anomalies diff =  $-0.34 \pm 0.24 \text{ Wm}^{-2}/\text{decade}$  with 2-sigma*

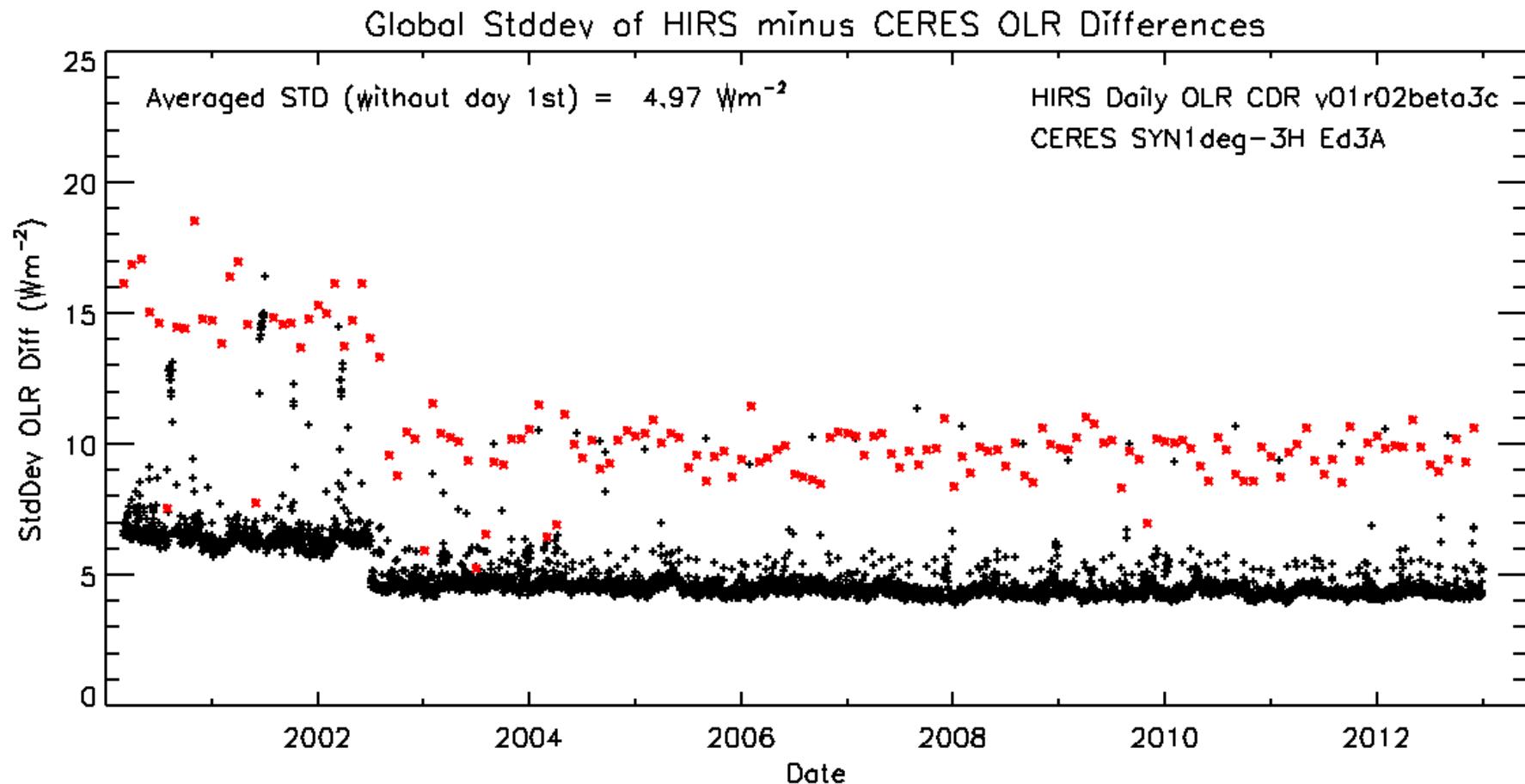
# **Inter-comparison**

**HIRS Daily OLR CDR**

**vs.**

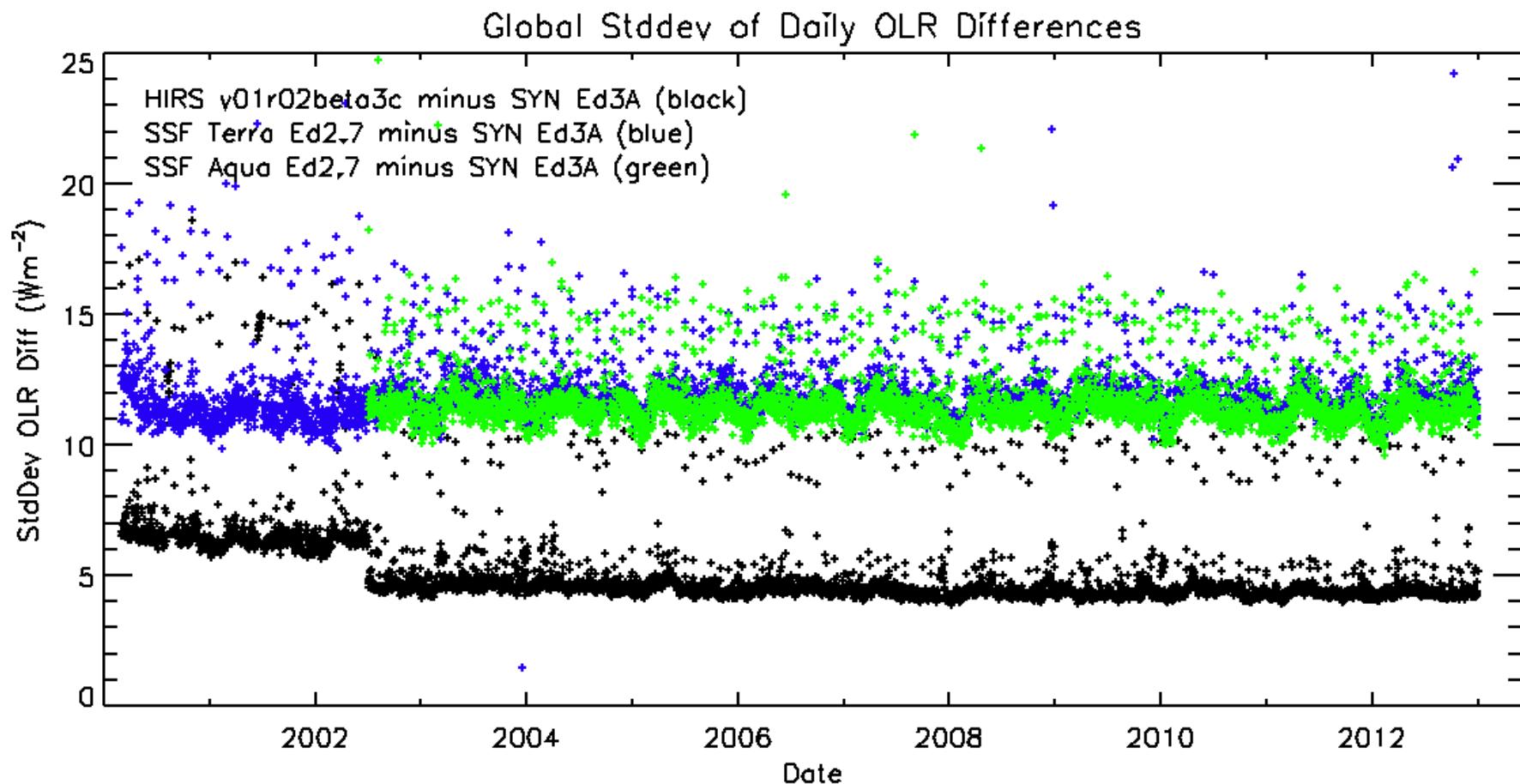
**CERES SYN1deg-3H  
(in daily means)**

# Global STD of Daily OLR Differences



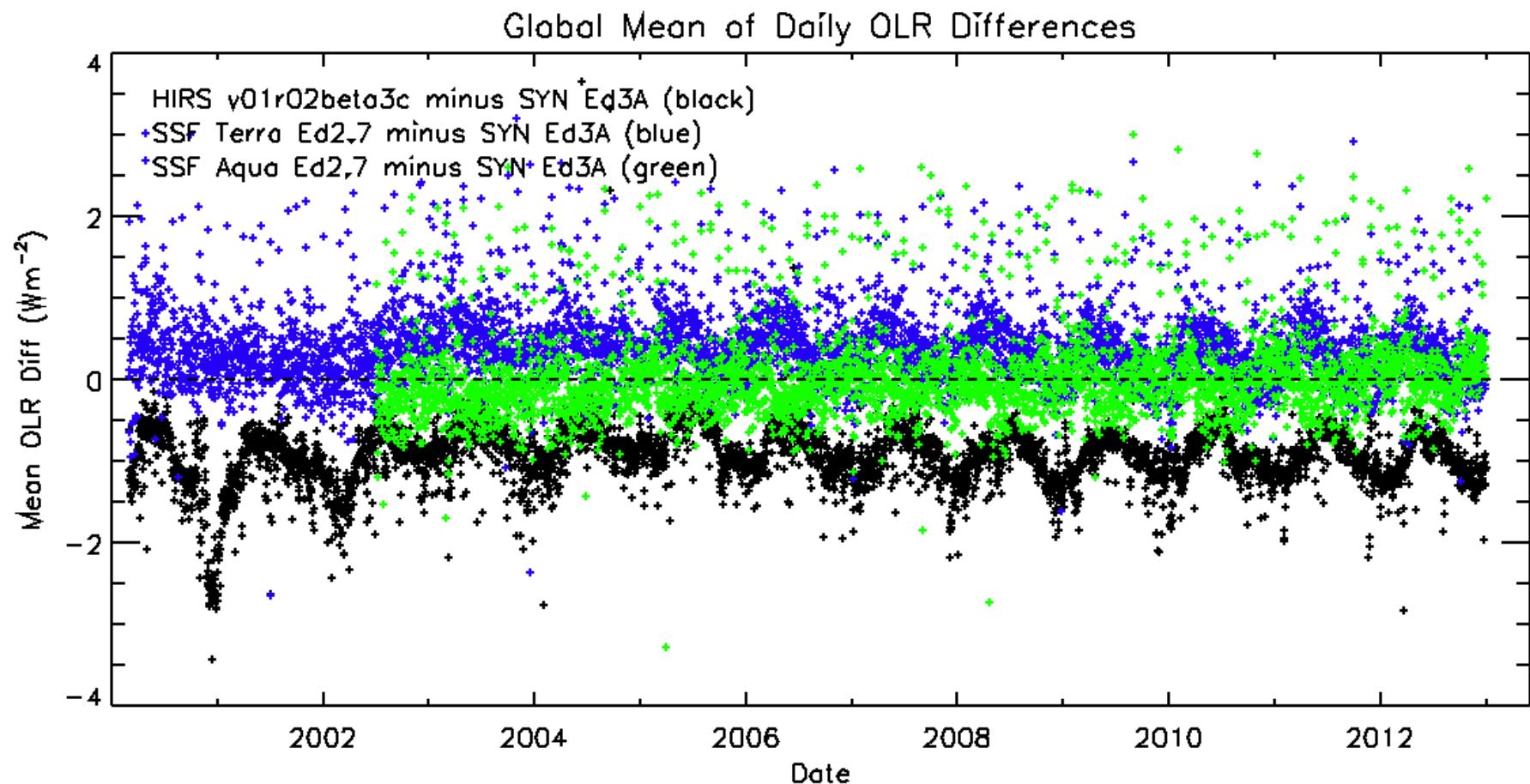
- *CERES SYN1deg-3H Ed3A has a processing bug on 1<sup>st</sup> day of each month (red points).*
- *Time series ‘shock’ due to CERES sampling change when Aqua entered in July 2002.*

# Global STD of Daily OLR Differences



- *StdDev of SSF minus SYN OLR are about  $12 \text{ Wm}^{-2}$*
- *StdDev of HIRS minus SYN OLR are about  $5 \text{ Wm}^{-2}$*

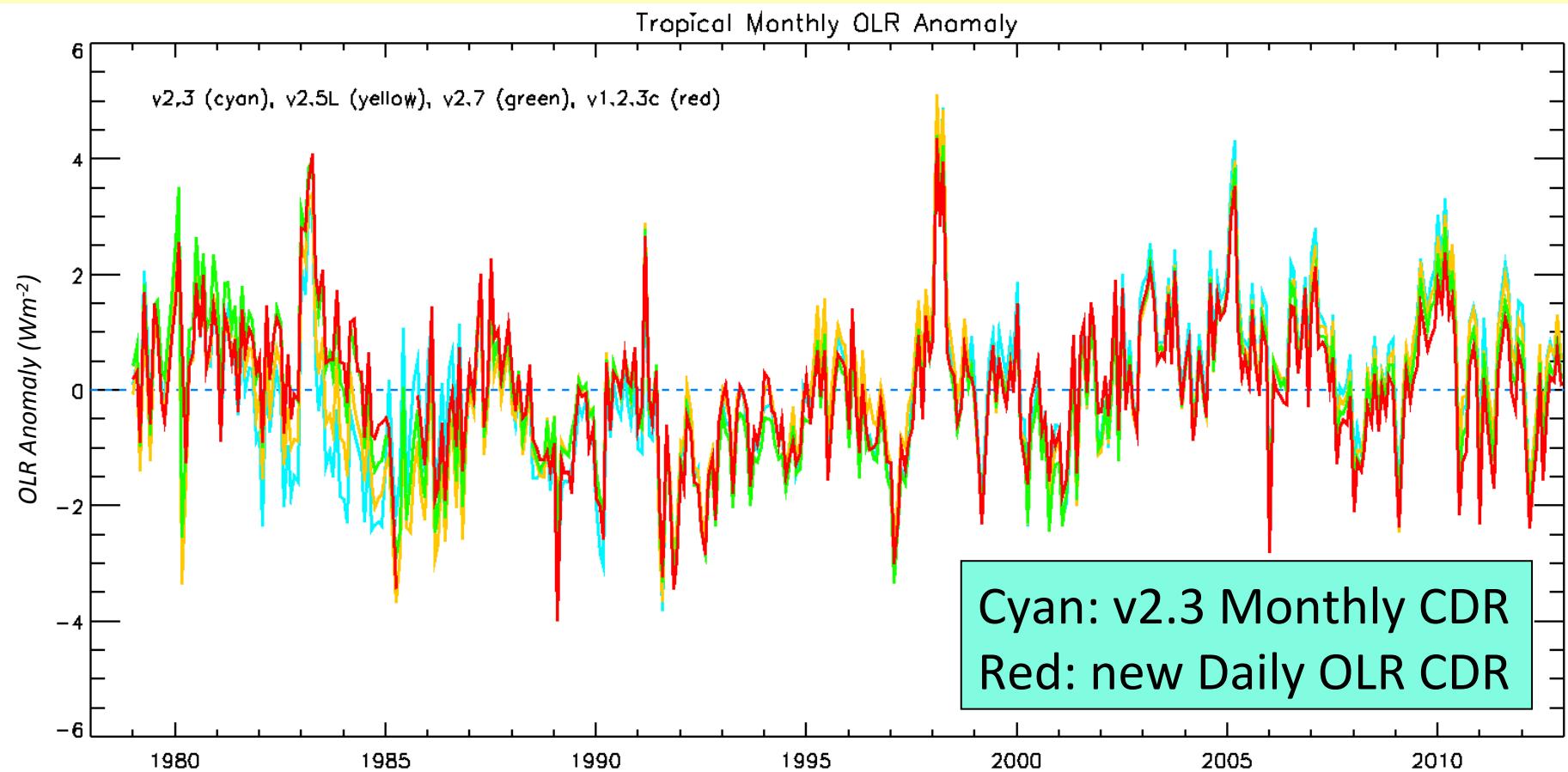
# Global Mean of Daily OLR Differences



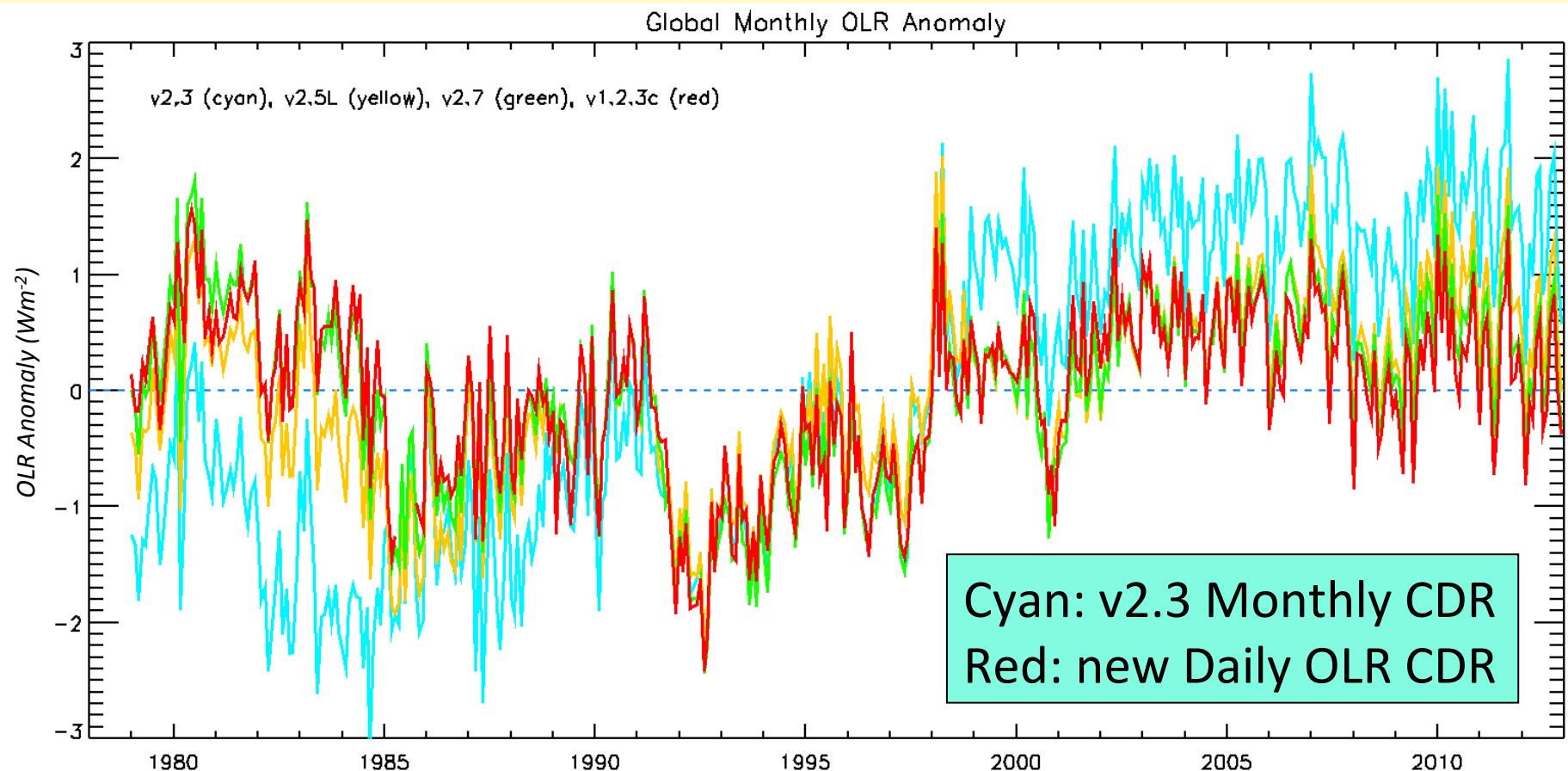
- *HIRS-SYN diff are well within CERES LW 1.5% uncertainty*
- *Global mean OLR diff vary seasonally in a range of about 1  $\text{Wm}^{-2}$  in both HIRS and SSF data relative to SYN.*

# **Status Quo of HIRS OLR CDR**

# Tropical Monthly OLR Anomalies (1979-2012)

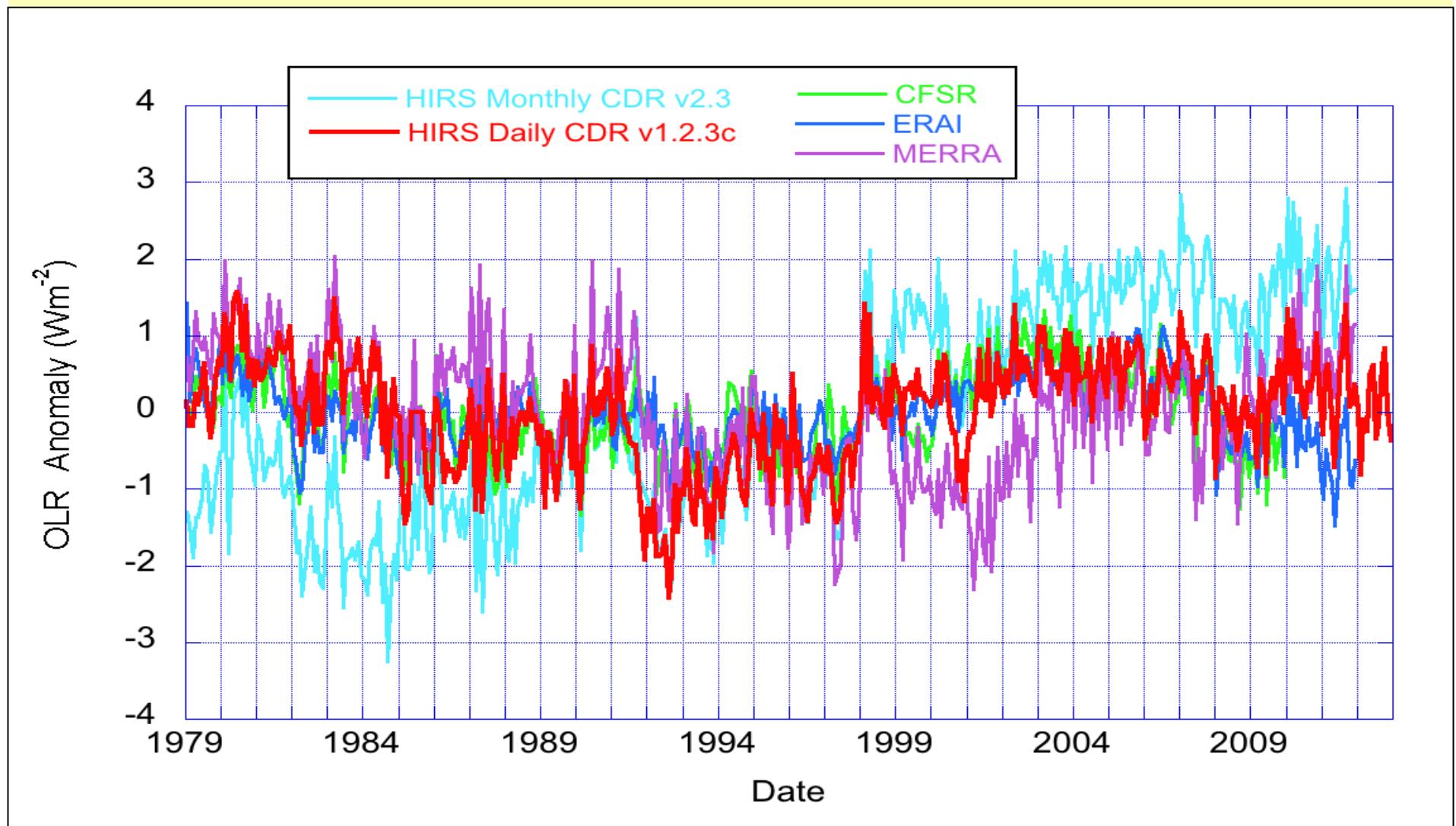


# Global Monthly OLR Anomalies (1979-2012)



# Global Monthly OLR Anomalies

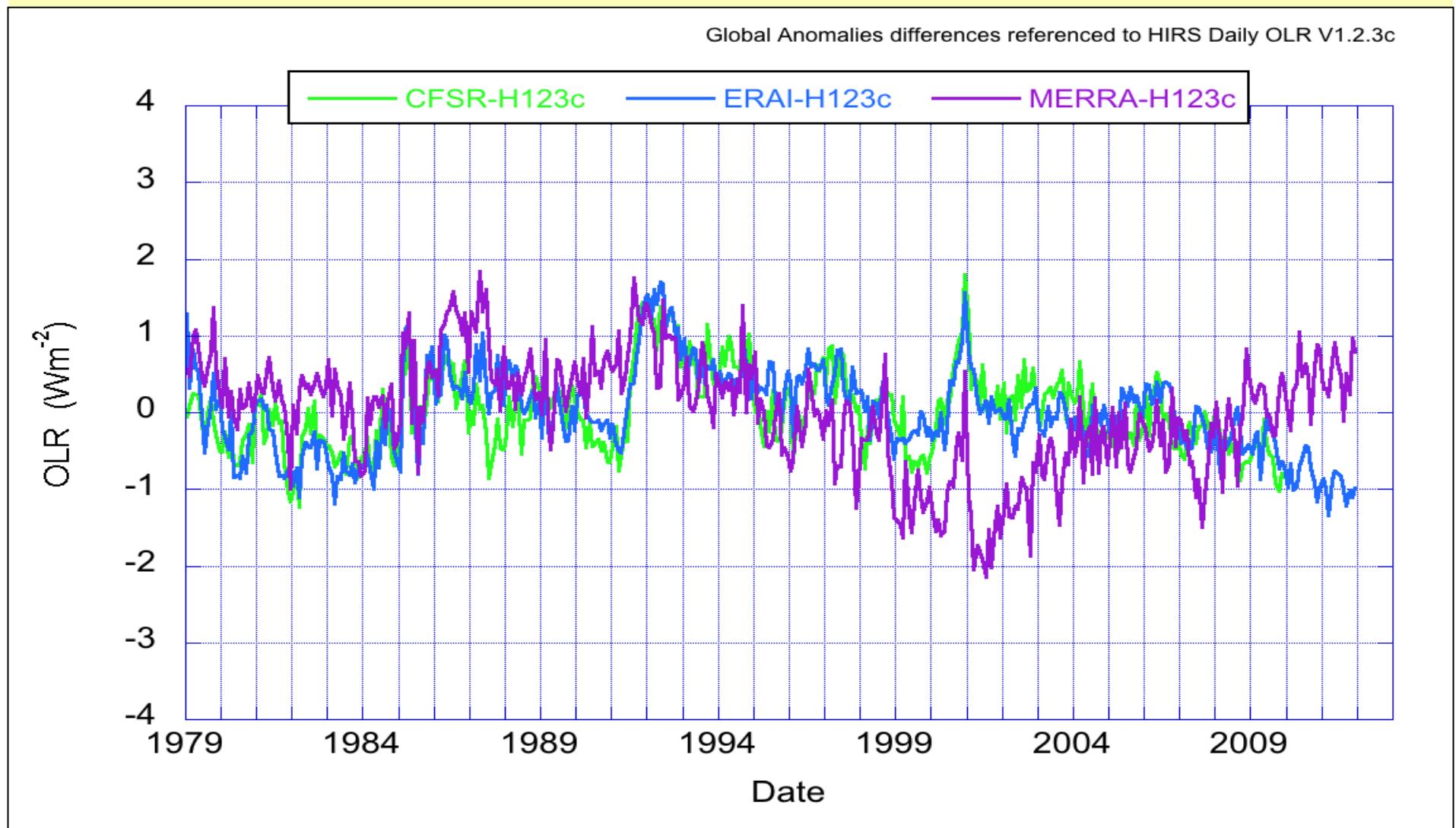
## 1979-2012



# **BACKUP SLIDES**

# Difference of Global OLR Anomalies

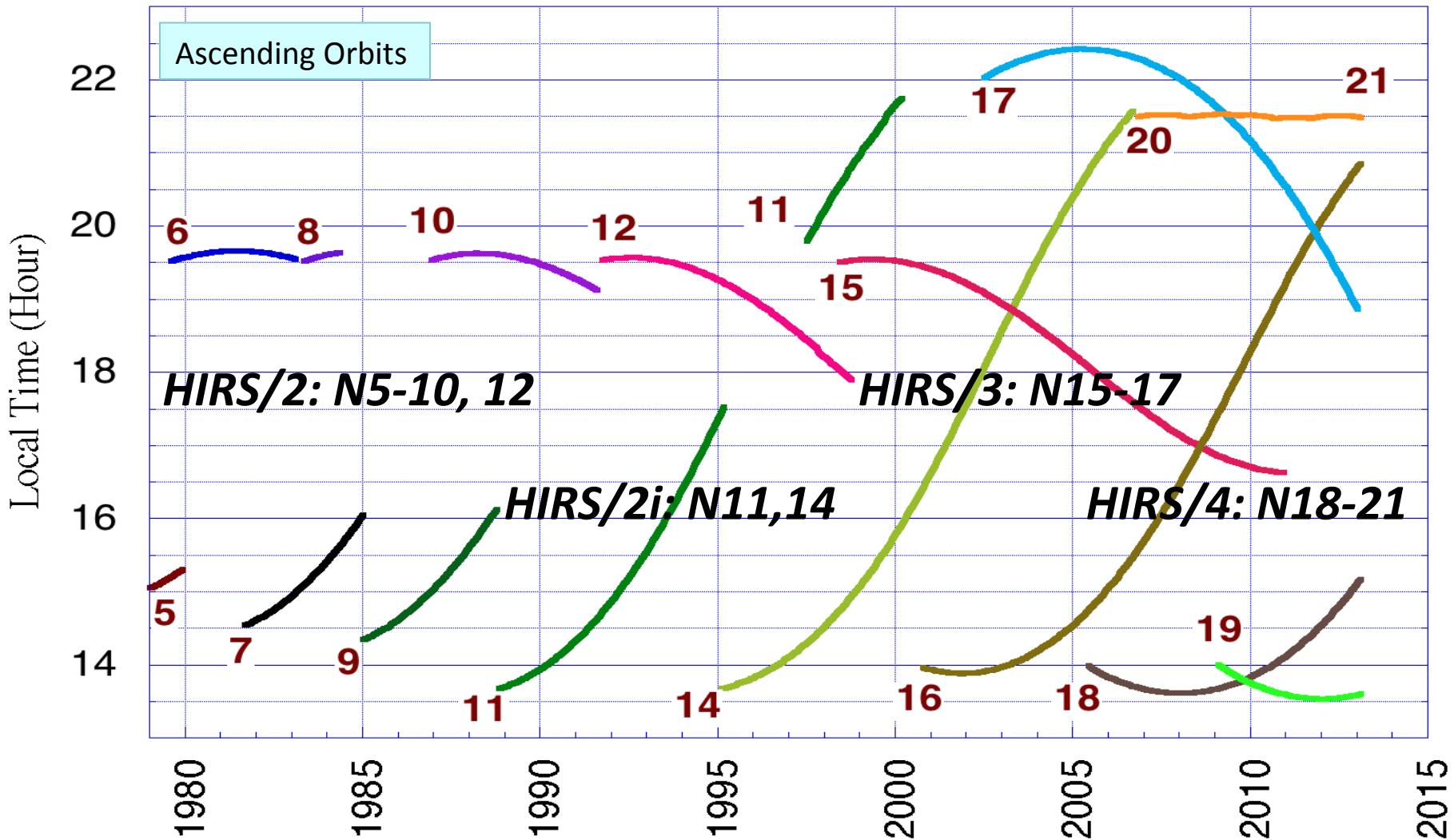
## Reanal minus HIRS



# Datasets

- **HIRS** Monthly OLR Climate Data Record v2.2/v2.3 and Daily OLR CDR v1.2.3c for 1979.01-2012.12 ([UMD-CICS/NCDC CDR Program](#))
- CERES EBAF Ed2.6r, Terra/Aqua SSF1deg Ed2.6, SYN1deg Ed3A. 2000.03-2012.06 ([NASA LaRC ASDC](#))
- NCEP Climate Forecast System Reanalysis (**CFSR**) 1979.01-2009.12 ([NCAR CISL Data Research Archive](#))
- ECMWF European Reanalysis (**ERA**) Interim 1979.01-2011.12 ([ECMWF](#))
- NASA Modern-Era Retrospective Analysis for Research and Applications (**MERRA**) 1979.01-2012.02 ([NASA GES DISC](#))

# HIRS Family and Time of Observations



5=TIROS-N; 6-19: NOAA; 20=MetOp-2, 21=MetOp-1

